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Solar winds whip up power system problems

On Dec. 30, 1999, a NASA satellite monitoring weather conditions on the sun observed solar winds with the potential to produce sustained geomagnetic storm conditions in the Earth's atmosphere through the start of the new year. The National Oceanic and Atmospheric Administration issued a warning for a possible geomagnetic disturbance. The storm died down and no major power system disturbances were reported. But as the ll-year cycle of solar storms increases in intensity, more warnings and more geomagnetic disturbances are likely.

Geomagnetic storms caused by solar winds can wreak havoc with the electric utility power grid. The resulting bursts of protons and electrons from the sun can cause huge surges of electric current to flow through power lines, destroying transformers or tripping protective devices to take power lines and other equipment out of service and raising the possibility of widespread blackouts, say electric utility experts.

The problem for utilities is that incoming charged particles can move the magnetic field that surrounds the Earth and if a magnetic field moves in relation to a conductor, an electric current results. In this case, the conductor is the Earth itself, and the electric current that develops interferes with man-made electric systems.

Generally, these electric charges flow through the ground and dissipate. But, in areas where the Earth is relatively impervious to electricity (such as areas of dense igneous rock) the currents seek an easier path. Power lines provide the perfect alternative. Transformers are particularly susceptible to damage from these geomagnetically induced currents, or GIC.

A solar storm in March 1989 caused a blackout across Quebec and destroyed two transformers at the Salem 1 nuclear station in New Jersey. The transformers cost $8 million to replace. Damage from this storm extended as far as southern California. "The 200 failures during this storm would have been more severe if the storm had occurred during a peak load period when there is less safety margin in the bulk power transmission system," said Gene Gorzelnik, spokesman for the North American Electric Reliability Council.

"Transformers can suffer severe internal heating when they are exposed to GIC, especially if they are being continuously operated near their capacity rating," explained **Hella Shull**, a DSW dispatcher.

"Capacitor banks and static var compensators have tripped out during geomagnetic storms because of harmonics," Shull said. "This creates serious system problems, if not actual system outages."

Geomagnetic storms can lead to a systemwide collapse, according to transmission reliability experts. The interconnected power grid in the United States includes more than 6,000 generating units, more than (800,000 km) of high-voltage transmission lines, 12,000 major substations and innumerable lover voltage distribution transformers. Any of these elements can serve as an entry point for GIC, noted Shull. Voltage collapse is also more likely if a severe solar storm occurs during a peak-load condition.

"Then all of the more than 100 control centers that jointly coordinate generation across the nation to meet loads on the real-time network must work together to minimize GIC effects on the interconnected transmission system," she added.

In addition to complex circuit technology, the power transmission grid traverses a variety of geography. All these factors must be balanced.

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Defining a geomagnetic storm

A geomagnetic storm begins with the collision between solar winds and the earth's magnetic field. This collision often is the result of a violent solar storm that causes enormous flares of energy on the sun's surface.

Solar flares hurl dense waves of protons and electrons out into space. These solar winds interact with the Earth's magnetic field, creating a collision of energy. Occasionally this collision takes the form of a sudden impulse.

As solar winds pass the Earth, they can cause dramatic changes in the shape of the Earth's magnetic field. Electrons, protons and other ions contained in solar winds can enter the Earth's atmosphere, especially at the magnetic poles where the direction of the Earth's magnetic field lines allows an easier passage.

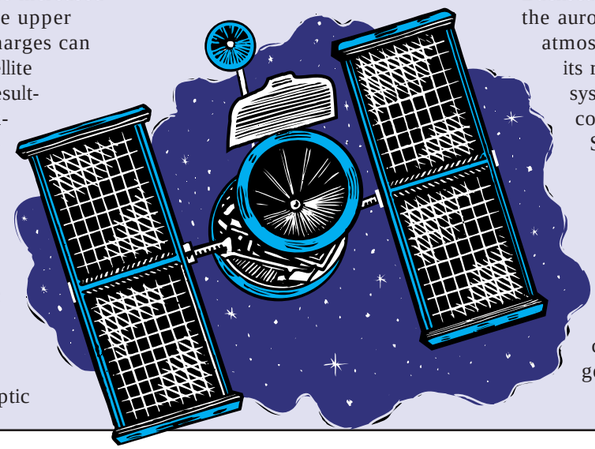
They come streaming down into our skies. We see them by the light emitted when they interact with our much denser atmosphere. We call this phenomenon the Northern Lights.

Magnetic storms damage communications systems

ower systems aren't the only technology susceptible to damage from geomagnetic storms. Satellites in low-earth orbit experience increased drag due to heating in the upper atmosphere. Electrical charges can build up on sensitive satellite electrical components, resulting in spurious logic commands or damage to vulnerable components.

Many land-based systems can also be affected.

Telecommunications equipment using metallic wire circuits can suffer many of the same problems that power systems do. Even modern fiber-optic transoceanic cables have an "electrical Achilles heel" because they use a network of metallic circuit power supplies for repeaters.



Air defense systems, including the Air Force's Over-the-Horizon Backscatter Radar, are hampered by the auroral activity in the upper atmosphere that can severely limit its range. Modern navigational systems, such as military and commercial Global Position System data, can be affected. High-frequency radio systems can also be knocked out by GIC. Shortwave broadcasts, including BBC Radio, police, fire and other emergency broadcast networks can all suffer damage from geomagnetic storms.